

QUICK REVISION MODULE [UPSC PRELIMS 2022] GEOGRAPHY

INTERIOR OF THE EARTH

SOURCES OF INFORMATION

1. DIRECT SOURCES.

- Mining – By studying the composition of different rocks and minerals.
- Exploration projects – “Deep Ocean Drilling Project” and “Integrated Ocean Drilling Project”.
- Volcanoes – The erupted magma is studied to know the interior of the earth.

2. INDIRECT SOURCES.

2.1 Temperature- Temperature goes on increasing with the increase in depth inside the earth. On an average, there is a rise of 1-degree Celsius temperature for every 32 meters of depth.



Reasons for the increase in heat and temperature:

- Radioactive disintegration within rocks which liberates heat.
- Internal and external forces (gravitational pull, weight of overlying rocks etc.).
- Chemical reactions.

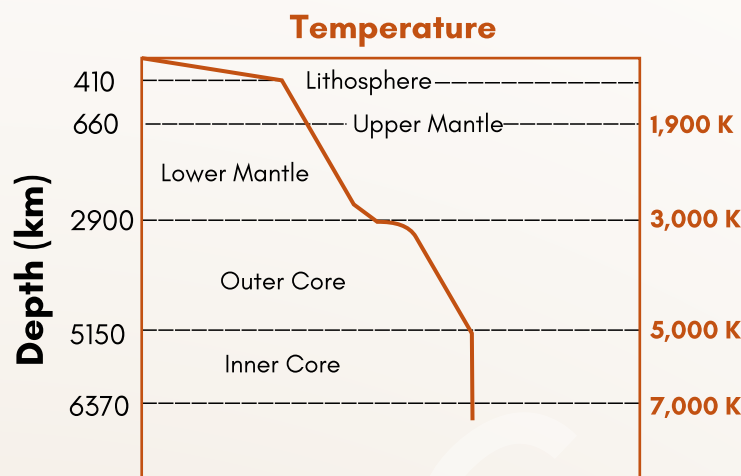


Fig: Temperature profile of the inner Earth

2.2 Pressure-

- ▶ Pressure **increases with depth** in the interior of the earth.
- ▶ Due to enormous pressure, liquid state rocks of the core have the properties of solids.

2.3 Density-

- ▶ Density **increases** with the increase in depth.
- ▶ The earth's internal part is composed of very dense rocks.

2.4 Gravitational force/Gravity anomalies

- ▶ The gravitational force is greater near the poles and less at the equator.
- ▶ The distance from the centre at the equator being greater than that at the poles.

Gravity Anomaly

- » The gravity values differ according to the mass distribution inside the earth.
- » It gives information about the distribution of mass of the material in the crust of the earth.
- » It inform about the distribution of molten material in the crust of the earth.

2.5 Magnetic Survey

- ▶ The rapid spinning of earth creates electric currents in the center (molten outer core) that creates a magnetic field around the earth.
- ▶ The magnetic north and south poles do not coincide with geographic north and south poles.

2.6 Meteorites

- ▶ Originated during the formation of solar system.
- ▶ Both meteorites and the earth are made of similar materials.

2.7 Moon

- ▶ The movements of the moon and its distance from earth provide the mass of the earth.

2.8 Evidence from theories

- ▶ Heavier materials (like iron) sink towards the center of the earth and the lighter ones moved towards the surface.

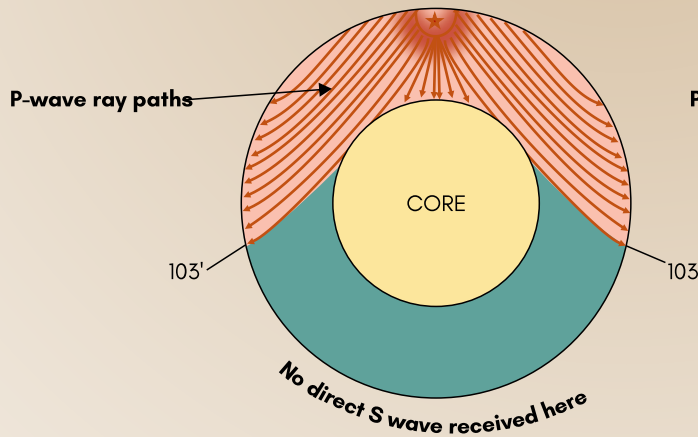
SOURCES OF INFORMATION

- ❑ The denser the material, the higher is the velocity of seismic waves through them.
- ❑ Their direction changes with change in medium (**Refraction**).
- ❑ **Shadow Zones:** Places where seismic waves are not recorded.

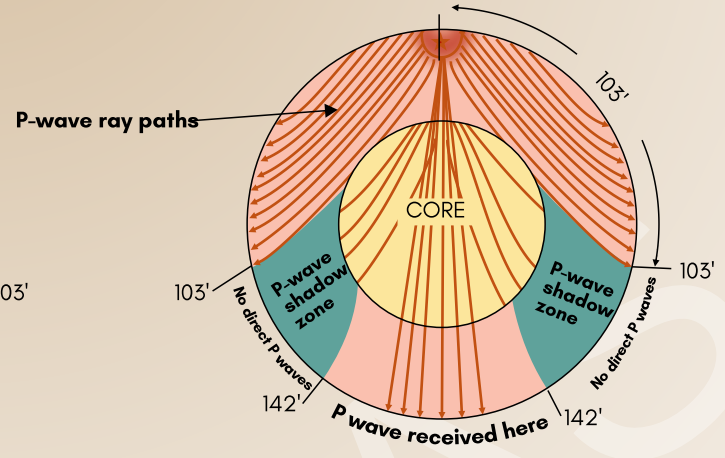




- ❑ **S-waves** are **not recorded beyond 103 degrees** angular distance from focus (indication of molten outer core)
- ❑ **P-waves** are not recorded between angular distances of **103 degrees to 142 degrees** (indication of different densities, state and composition of core)



S-wave shadow zone



P-wave shadow zone

Types of Earthquake Waves: Body & Surface Waves

- 1. Body Wave:** Can travel **through the earth's inner layers**.
 🕒 P-waves and S-waves.
- 2. Surface Waves:** Can only move **along the surface** of the planet like ripples on water.

	Body Waves		Surface Waves
Parameters	'P' - Waves or Primary wave	'S' - Waves or Secondary wave	'L' - waves
1. Type of Wave	Longitudinal	Transverse	Transverse
2. Nature of movement	Particles are displaced in backward-forward direction. (Compression waves.)	Particles swing side by side (Shear waves).	Travels on to the surface of the earth only.
3. Velocity	Fastest.	Lower than the primary waves.	About 3.5 Km/s
4. Medium of Travel	They can travel through all mediums - solids, liquids & gases.	They travel through solids only.	They cause the greatest damage and destruction of property during the earthquake.

STRUCTURE OF THE EARTH'S INTERIOR

Based on the passage of earthquake waves through different types of rocks and their behavior it can be concluded that the earth's interior has three main layers. These three layers are:

- (i) Crust (ii) Mantle (iii) Core



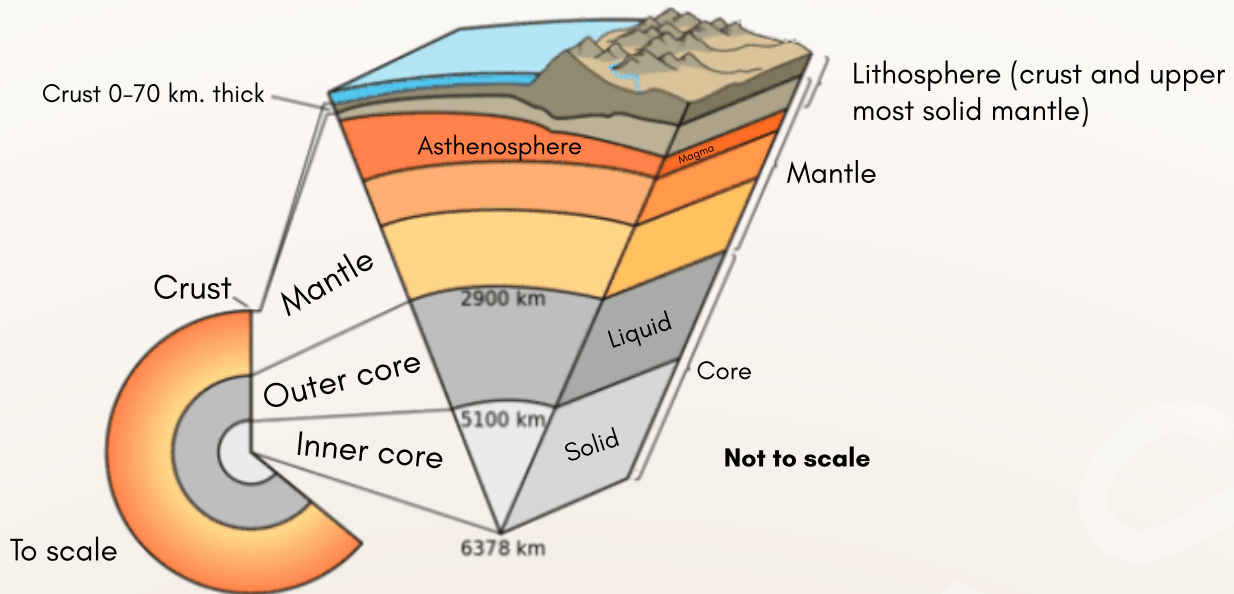


Fig: Interior of the earth

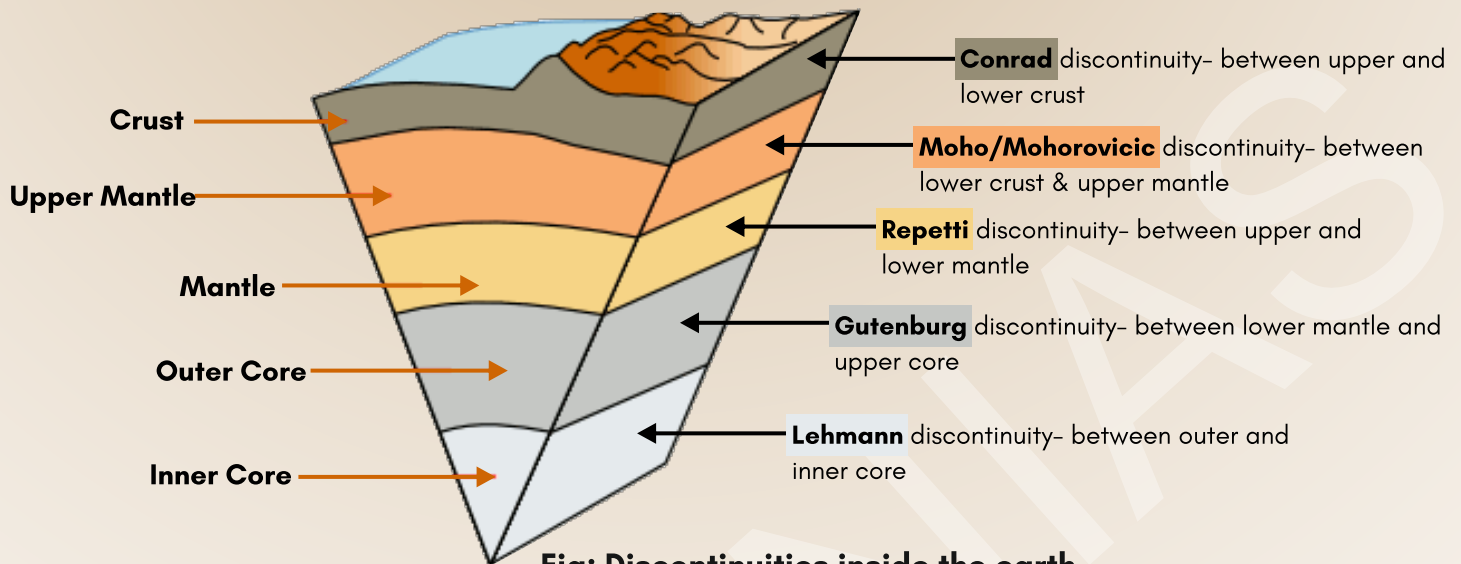
The Crust	The Mantle	The Core
<ul style="list-style-type: none"> ➤ Earth's uppermost layer. ➤ Its volume is 1% of the total volume of the earth. ➤ Solid, rigid and very thin compared with the other two. ➤ Oceanic crust is thinner as compared to the continental crust. ➤ It's two main parts are: <ul style="list-style-type: none"> 1. The uppermost thin layer- <ul style="list-style-type: none"> ➤ Composed of rocks containing a large proportion of Silica & Aluminum, called SIAL. ➤ Average density is 2.7 and thickness is of about 28 kilometers. 2. The lower layer- <ul style="list-style-type: none"> ➤ Composed of comparatively heavier rocks containing Silica and Magnesium in large proportion, called SIMA. ➤ Average thickness is 6-7 kilometers and density of about 3.0. 	<ul style="list-style-type: none"> ➤ Its thickness is about 2900 Km. ➤ Its volume is 83% of the whole earth. ➤ Made up of dense & heavy materials such as oxygen, iron and magnesium. ➤ Surface discontinuity between the crust and the mantle, Mohorovicic Discontinuity. ➤ The temperature is quite high and the hot rocks form magma in this layer (Asthenosphere). ➤ Mantle gives rise to Convection Currents. 	<ul style="list-style-type: none"> ➤ It is the interior most part of the earth and begins from Gutenberg Discontinuity. ➤ The volume of the entire core is 16% of earth as a whole. The mass of the core is 32% of the earth's mass. ➤ Mostly made up of heavy metals like Iron and Nickel (NIFE). ➤ It is divided into two parts: <ul style="list-style-type: none"> 1. Outer Core- <ul style="list-style-type: none"> ➤ It is possibly in wholly liquid or semi-liquid state. ➤ The transverse or S-waves of earthquakes, seem to disappear at the Gutenberg Discontinuity. 2. Inner Core- <ul style="list-style-type: none"> ➤ It is believed to be solid. ➤ The velocity of P waves increases at the boundary of outer and inner core.





DISCONTINUITIES INSIDE THE EARTH

- Materials inside the earth are different from each other by their physical and chemical properties, such as temperature, density etc.
- Inside the earth, layers are arranged according to their characteristics.
- All those layers are separated from each other through a transition zones, called discontinuities. There are five discontinuities inside the earth.






ROCKS AND MINERALS

Rocks and minerals account for about 99 percent of the materials found in the outer layer of the lithosphere. Oxygen and Silicon account for about 75 percent of the earth's crust by weight.

MINERALS




- Minerals are those substances which occur naturally in rocks.
- Minerals are often classified as metallic and non-metallic.

Some Major Minerals and Their Characteristics:

Minerals	Composition	Importance	Other facts
 Feldspar	Common feldspar= silicon and oxygen. Specific feldspar= sodium, potassium, calcium, aluminum.	Used in ceramics and glass making.	Half of the earth's crust is composed of Feldspar.
 Quartz	Consists of silica.	Prominent components of sand and granite and used in radio and radar.	Hard mineral virtually insoluble in water .
 Pyroxene	It consists of calcium, aluminum, magnesium, iron and silica.	Commonly found in meteorites .	Pyroxene forms 10 per cent of the earth's crust.





 Amphibole	Aluminum, calcium, silica, iron, magnesium are the major elements of amphiboles.	Used in asbestos industry. Hornblende is another form of amphiboles.	They form 7 percent of the earth's crust.
 Mica	It comprises of potassium, aluminum, magnesium, iron, silica etc.	Used in electrical Instruments.	
 Olivine	Magnesium, iron and silica are major elements of olivine.	Commonly found in meteorites .	Pyroxene forms 10 per cent of the earth's crust.

ROCKS

- Rocks are generally a mixture of two or more minerals and do not possess a definite chemical composition.
- On the basis of their mode of formation, rocks can be classified into the following three types-
 1. Igneous rocks
 2. Sedimentary rocks
 3. Metamorphic rocks

Parameters	Igneous rocks	Sedimentary rocks	Metamorphic rocks
Formation	<ul style="list-style-type: none"> ● These rocks are of thermal origin. ● Formed due to solidification of hot & molten material called magma. 	<p>Rain, wind, ice running water, plants and animals break the rocks into fragments.</p> <p style="text-align: center;">↓</p> <p>The broken rock materials are carried away by wind, ice, and running water, and deposited in the depressions in a horizontal layers or strata.</p> <p style="text-align: center;">↓</p> <p>The loose materials are converted into hard and compact rocks.</p>	<p>The rocks, originating at or near the surface of the earth are subjected to tremendous heat and pressure.</p> <p style="text-align: center;">↓</p> <p>Change in the original properties of rocks such as their color, hardness, texture, and mineral composition.</p>
Types/ Classification	<p><u>On the basis of place of formation:</u></p> <ol style="list-style-type: none"> 1) Intrusive igneous rocks- <ul style="list-style-type: none"> ● Cool below the surface of the earth. ● The crystals formed on cooling are large. ● Example= Granite, Dolerite etc. 2) Extrusive igneous rocks (Volcanic rocks)- <ul style="list-style-type: none"> ● Cool on the surface of the earth. ● Crystals are fine grained. ● Example= Basalt. 	<p><u>On the mode of formation :</u></p> <ol style="list-style-type: none"> 1) Mechanically formed- <ul style="list-style-type: none"> ● Formed by mechanical agents like running water, wind, ocean currents, ice etc. ● Example= Geyserite, chalk, limestone, coal etc. 2) Organically formed- <ul style="list-style-type: none"> ● The remains of plants and animals are buried under sediments, & due to heat and pressure from overlying layers, their composition changes. ● Example= Coal, limestone, halite, potash etc. 	<p><u>On the basis of metamorphism:</u></p> <ol style="list-style-type: none"> 1) Thermal metamorphism- <ul style="list-style-type: none"> ● Changed under the influence of high temperature inside the earth's crust. ● Example= Limestone is converted into Marble, Sandstone into Quartzite, Shale into Slate, Coal into Graphite.





	<p>On the basis of composition:</p> <p>1) Acidic igneous rocks-</p> <ul style="list-style-type: none"> ● Silica content is more than 65%. ● Light colored and have less density. ● Example= Granite, Rhyolite etc. <p>2) Basic igneous rocks-</p> <ul style="list-style-type: none"> ● Silica content is less than 65% and composed predominantly of ferro-magnesian minerals. ● Dark colored and dense. <p>Example= Gabbro, Basalt etc.</p>	<p>3) Chemically formed-</p> <ul style="list-style-type: none"> ● Formed by various chemical reactions. ● Limestone, halite, potash etc. 	<p>2) Dynamic metamorphism-</p> <ul style="list-style-type: none"> ● Changed under the influence of pressure at great depths inside the earth's crust. ● Example= Granite is converted into Gneiss, Shale into Schist.
Characteristics	<ul style="list-style-type: none"> ● Compact and massive and do not possess rounded particles. ● Do not occur in distinct beds or strata. ● Generally, granular and crystalline. ● Do not contain any fossils. ● Mostly consists of silicate minerals. ● Valuable minerals such as iron, gold, silver etc. found in them. 	<ul style="list-style-type: none"> ● Softer than the igneous rocks. ● Mostly formed under water. ● Presence of fossils between the layers. ● Most of them are permeable and porous. 	<ul style="list-style-type: none"> ● Hard. ● High specific gravity. ● Do not have void spaces in between. ● May be banded.
Economic Importance	<ul style="list-style-type: none"> ● Majority of metallic minerals are found in igneous rocks. ● Used for construction of buildings and roads. ● Black soils are formed due to erosion of these rocks. 	<ul style="list-style-type: none"> ● Minerals like iron ore, phosphates, coal are obtained. ● Mineral oil and natural gas are also obtained. ● Sandstone, limestone is used in construction of buildings. 	<ul style="list-style-type: none"> ● Building construction materials (BCM) like Gneiss, Quartzite, Slate, Marble. ● Industrial uses, for example, Graphite is used for making pencil. ● Asbestos in fire resistant. ● Garnet used for making abrasives

ROCK CYCLE:

- The change of one type of rock into another type under different conditions is known as the rock cycle.
- It is powered by two main sources of energy:
 1. The solar energy responsible for weathering and erosion; and finally converting them into a sedimentary rock.
 2. The heat inside the earth, which can melt the existing rocks.



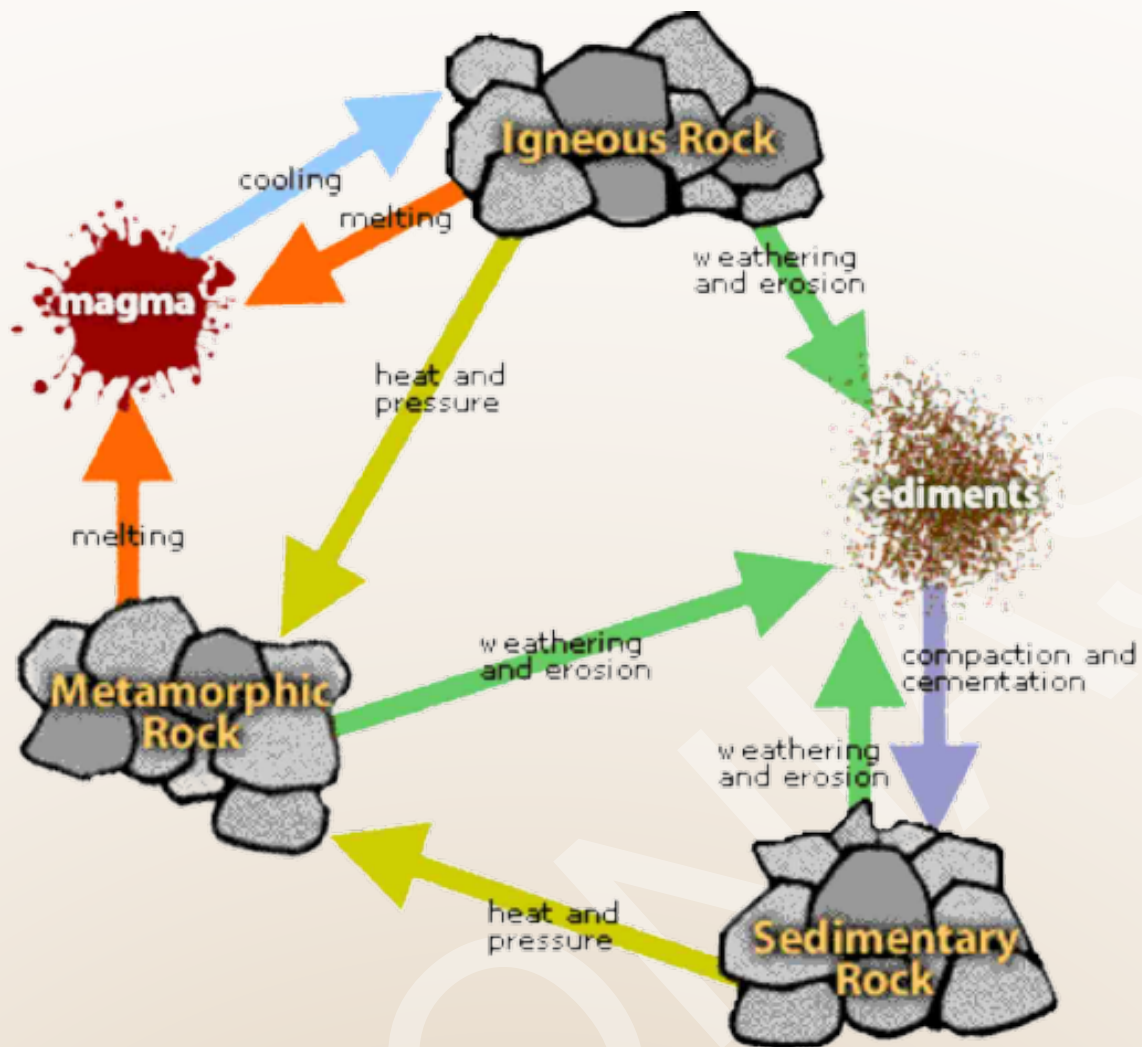


Fig: Rock cycle.

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